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REPORT ON NEFF CANYON INVESTIGATION CONDUCTED DURING THE YEAR 1948

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The filing of Permanent Change Application No. a-2084 and Applications No. 18056 and 18119 brought protests from certain water users interested in the springs at Holladay, also those using the spring runoff water of Neff Canyon.

A number of hearings were held. It was concluded that more information on the creek and springs was needed. The State Engineer and all others interested agreed that the writer should conduct the investigation. Everyone concerned was very cooperative in constructing weirs, etc. The Mt. Olympus Park, Inc., agreed to let the creek water remain in the creek and not put it in the newly-constructed, concrete pipe line; the water was to be allowed to run as it had previously done.

On May 11, 1948, the water in the 6-inch, cast-iron pipe line was cut to 91.8 g.p.m., or as near that as possible. This 91.8 g.p.m. was taken into the Mt. Olympus and Taylor pipe lines and does not enter into any of the creek measurements. The rest of the creek water, also the Holladay springs, was observed and very carefully measured.

The characteristics of the creek and the Holladay springs, also the total quantity of water in acre-feet, are shown on the hydrographs and charts.

Hydrograph No. 1 represents the variation of the flow of Neff Canyon and Norths Fork during the year of 1948. The drainage area of these two forks is known as Neff Canyon. In this report, however, Neff Canyon is used as applying only to the largest drainage area and does not include Norths Fork. The weirs over which the measurements were made are located above the confluence and, therefore, each stream was measured separately. There is water in Norths Fork during the entire year, but after the spring runoff it consists entirely of the water coming from Mt. Olympus Springs. Its rise and fall is very rapid, but not as rapid as that of Neff Canyon. The drainage area of Norths Fork, above the weir, is 0.86 sq. mi., while that of Neff Canyon, above the weir, is 2.54 sq. mi. The total quantity of water measured over the weir in Neff Canyon was 381.7 ac. ft. for 1948, and the total from Norths Fork was 748.0 ac. ft., or 5.78 times as much per square mile came from Norths Fork. This astonishing fact, together with the fact that the rise and fall of the creek flow at the weir of Neff Canyon is so abrupt, forces one to conclude that Neff Canyon is losing most of its water above the weir. This is assuming, of course, that these two small drainage areas receive the same amount of precipitation per unit area during the year.

Hydrograph No. 2 represents the flow of the Holladay springs and is most interesting and instructive. To a person who has studied the rise and fall of valley springs it is difficult to believe that this is a hydrograph of a valley spring and not a stream; the rise and fall of these springs is so rapid. They commence to decrease before the first of June, which is even before the larger creeks of this area have reached a maximum. The maximum flow of the Casto Spring is about 27 times greater than the minimum, which is another characteristic of a creek and not a valley spring.

For comparison's sake, there has been obtained from Salt Lake City water department, Hydrographs No. 3 and 4. No. 3 shows the rise and fall of the ground-water levels obtained from a City well located at 3500 South and 2100 East. Note how gradual and sustained the rise and fall is compared to that of the Holladay springs. In this well the highest level is reached about the first of September, and the lowest is in the middle of April. This is also true of the Luck Spring, which is represented by the hydrograph on the same sheet. The similarity of these two graphs is immediately recognized, although one represents water level in the ground and the other the flow of water from a spring. One interesting factor is that the maximum flow of the spring is about 2.6 times that of the minimum.

The recharge to the ground in the area of this well and spring comes primarily during a short period of time when the creeks are high in the spring, yet the rise and fall of the Luck Spring and the City well is very gradual and covers the entire year. There is no time when the water level remains constant. These graphs also indicate the great storage capacity of the valley fill of unconsolidated materials. The storage capacity is made possible only because water does not flow rapidly through this unconsolidated material. The water surface must be increasing higher from the outlet towards the recharge areas. These valley fills have a great capacity to store and release water gradually.

Hydrograph No. 4 represents the flow of Little Cottonwood Creek, whose maximum flow is for a very short time, and is about 24 times greater than the minimum flow. Also, the flow of Beaver Pond Spring is represented by the lower graph. Its characteristics are different from that of the creek. The maximum flow of the spring is only 1.5 times greater than the minimum flow. There are very definite indications of considerable storage capacity in the mouth of Little Cottonwood Creek, from which Beaver Pond Spring is fed and recharged. The characteristics of this spring are entirely different from those of the Holladay springs.

Now to return to the hydrographs of the Holladay springs. They have practically the same characteristics as a creek; their rise and fall is so abrupt. The maximum flow of Casto Spring is 27 times greater than the minimum. The storage capacity of the source of these springs is no greater than that of a ~~creek~~ stream. This is not so true of Spring Creek. It appears to have a greater storage capacity than the other two springs. Its higher, sustained flow is due to the fact that it is lower in elevation than the other two. Its rise and fall is just as rapid, however. There is no doubt that all three springs are fed from the same source. These springs are on the decrease before the first of June, while the ground-water levels in this area start to increase about the first of May and do not reach a maximum before the first of September. Also, the Holladay springs have none of the characteristics of springs that issue from unconsolidated material, such as the Luck and Beaver Pond Springs. The ground-water levels in the valley, along a line extending north and south of the Holladay springs, are at an elevation far below the elevation of the springs. It is impossible for unconsolidated material to yield water in the manner these Holladay springs vary, unless the unconsolidated material from beginning to end is as porous as a creek channel. We must, therefore, look for a source of water to supply these springs other than that which may be stored in the unconsolidated material above the springs.

There is only one other source and that is Neff Canyon itself, which makes a very unusual and interesting hydrological study. An effort was made to determine the total precipitation in inches that may fall in Neff Canyon during the year. This figure was very difficult to arrive at because measurements of the snow and its water content have not been made in Neff Canyon. A guess could be made, but perhaps little would be gained by it. We can, however, make comparisons between the drainage area and runoff of Neff Canyon and Norths Fork, which was brought out in the forepart of this report. The conclusion is that only a small part of the precipitation falling in Neff Canyon may be measured over the weir at the "Y" as runoff.

It appears that water does not reach the "Y" from Neff Canyon until the stream has reached a certain stage. It has been stated by those acquainted in this area, that there have been years when no water at all reached the "Y" from Neff Canyon.

From January 1 to May 4, 1948, all the water coming from Norths Fork, including the Mt. Olympus Spring, had been running down the 6-inch, cast-iron pipe line and the concrete pipe line. On May 4 the water was turned from these pipe lines into the creek at a point immediately below the Mt. Olympus Spring. Approximately 200 g.p.m. was left running down the 6-inch, cast-iron pipe line until May 11, when it was cut to 91.8 g.p.m. On the morning of May 4 there was 2.15 sec. ft. turned into the creek over the weir at the spring. All this water was lost within 450 feet of the weir. As the flow increased the water would reach farther down the creek. The water had a difficult time getting over a little area known as the "sump", making only 20 to 50 feet a day. It appeared as though all of the water coming over the weir was actually lost in the sump. The maximum flow lost in the sump was 3.77 sec. ft. The next day the creek came up to 5.08 sec. ft., part of which was going over the sump and down the creek. An estimate of that going down the creek was not made. Two days later there was 4.32 sec. ft. in the creek, of which 2.5 sec. ft. was going past the "Y" and down the creek. The loss in the sump was about 1.82 sec. ft. It appeared as though the sump was taking less water each day after the maximum sump loss.

On the morning of May 28 I noticed that someone, the night before, had turned all the water from Norths Fork down the concrete pipe line, leaving the section of the creek between Mt. Olympus Spring and the "Y" dry. Water coming from Neff Canyon was at a maximum at this time. I turned 0.75 sec. ft. over the weir at the spring into the creek. In 20 minutes this small stream of water ran over the sump area and it was estimated 0.60 sec. ft. entered the stream coming from Neff Canyon. This means that approximately 0.15 sec. ft. was lost in the sump area. After the 10th of June, when the creek flow had decreased to about one-third of the maximum flow, it was noted that the loss in the sump again increased.

From the observations and readings made it is considered that, roughly speaking, 97.0 ac. ft. of water was lost in the sump, which is 1.94 per cent of the amount coming from the Holladay springs during the entire year and 7.2 per cent of the amount of water coming from the Holladay springs during the same period of time.

The loss in the creek channel, between the "Y" and the Mulholland head gate, does not vary in the same way as the loss in the sump area. For nine or ten months, between July 1 and April 15, the creek channel between the "Y" and Mulholland head gate is dry. In this time the water that saturated the unconsolidated material, through which the creek winds its way, has drained out. The next spring, during the months of May and June, a large amount of water is lost in the creek until the unconsolidated material in the bottom of the channel has again been saturated. It took an average stream of 2.23 sec. ft. six days to reach the Mathews head gate from the "Y". After the channel has been saturated the loss is more or less constant, varying with the temperature. When there was an average of 5.27 sec. ft. of water over the weir in Neff Canyon there was an average loss of 0.73 sec. ft. between the weir in Neff Canyon and the Mathews head gate. Water from Norths Fork was turned down the concrete pipe line while these readings were being made. It was necessary to wait until the creek was at this stage, for the weirs will not measure accurately much more than 4 or 5 sec. ft. It was also necessary to use the water of Neff Canyon to measure the loss in this section of the creek and turn Norths Fork water down the concrete pipe line in order to eliminate the sump. The total quantity lost between the "Y" and Mathews head gate has been computed to be roughly 88.0 ac. ft.

97.0
88.0
185.0 ac ft.
Lost in channel of North's Fork and between the "Y" and Mathews headgate

During the same time when there was an average of 6.3 sec. ft. at the Mathews head gate there was an average loss of 0.58 sec. ft. in the channel between Mathews head gate and the Mulholland head gate. In order that the stream could be as large as possible and still maintain good measuring conditions, some of this water was measured at the head of the concrete pipe line and the rest over the weir at the Mathews head gate. There was considered to be no loss in the concrete pipe line. The total loss in this lower section of the creek was computed to be roughly 24.0 ac. ft. After the channel was saturated the loss in this section of the creek was about constant, varying with the temperature.

The readings to determine the loss in the creek channel were all made early in the morning in order to reduce the loss due to evaporation.

There was not a material increase in the loss of these two lower sections of the channel when the creek was high. At high flow the loss is greater, of course, but not in proportion to the increase in the creek flow.

During the maximum flow of the creeks and springs, it was noted that for the same few days the Mt. Olympus Spring was milky the Casto Spring was also milky. A screen was placed in front of the Parshall flume of Dry Creek Spring. Within a period of two or three days, during high flow, fibrous material had collected in front of this screen in such quantities that it was necessary to clean it before a satisfactory reading could be made. This material consisted mostly of small roots and decayed leaves. There was actually taken from this screen many parts of oak leaves as large as one-half inch square. The milkiness found in this water and the presence of this fibrous material is definite proof that the water of Holladay springs does not move through unconsolidated material of the type brought out of Neff Canyon, but strongly suggests cavern flow.

For thirty-six hours during June 21 and 22 there was a steady rain-storm. The storm was not heavy enough to cause water to run over the ground

surface, for the ground was able to absorb it as fast as it came down. There was absolutely no runoff in the neighborhood of the Holladay springs. If there had been a heavy runoff the water could not have entered the Dry Creek Spring flow ahead of the weir, yet there was a very definite increase in the flow of Dry Creek Spring, caused by this rainstorm. There was a much larger increase in the flow of the other two springs. In the case of Spring Creek and Casto Spring, domestic pipe lines take out above the weirs. As a result of the rainstorm there was no irrigation from the pipe line and so the weirs measured the decrease in irrigation, which was an increase over the weir, plus the increase caused by the rainstorm.

It is impossible to detect an increase in the flow of a spring issuing from unconsolidated material after a rainstorm. Rainstorms in the recharge areas sustain the flow of such springs. The increase is so very gradual, due to the large storage capacity of the valley fill material. The rapid increase in these Holladay springs may be accounted for if the rain fell on a consolidated rock formation that has very little storage capacity, and where it may be conveyed rapidly to a channel that affords very little friction to the flow of water.

Since making these measurements it has been learned from those acquainted in Neff Canyon that there are small caverns and sinks in this area; the evidence indicates that there must be.

Conclusions: hydrologic

The results of this investigation definitely indicate that there is sufficient precipitation and more in Neff Canyon and Norths Fork to account for the total flow from these canyons plus the Holladay springs. This, of course, is based upon the conclusion that Holladay springs are fed directly from Neff Canyon and perhaps Norths Fork. It is possible that Norths Fork, above and below Mt. Olympus Spring, may contribute to the flow of Holladay springs. It is believed that the greater part of the water coming from Mt. Olympus Spring comes from Neff Canyon. A variety of conditions could exist above the "Y". The writer did not try, and it was unnecessary, to obtain flow readings above the present weirs in each canyon. (Further investigation above the "Y" is not necessary at present, but would present a very interesting study, both from a geological and engineering standpoint. This study could very well include the actual measurements of precipitation in order that the relationship to the total runoff may be determined.)

I do not agree. R.E.H. ?

The problem

The reason for conducting this investigation was to determine, if possible, the amount of water lost in the creek channel between the intake of the concrete pipe line in each fork and the Mulholland head gate, and to learn if this water lost contributed in any way to the flow of the Holladay springs. The information obtained has made it necessary to divide this section of the creek channel into two parts. The dividing line is the shale formation crossing the creek channel right at the "Y", at the very point where the two streams meet. It is very possible that the water lost in the sump immediately above the shale in the Norths Fork channel contributes to the flow of the Holladay springs. The water lost in the creek channel below the shale does not contribute to the flow of the Holladay springs. The water lost in this section enters the unconsolidated material and turns north of west as the ground water moves towards the valley. The deposition of the unconsolidated material bears out this belief. The coarsest material of this fan lies in this direction. It would be almost impossible for

? I do not agree!

ground water from this fan to flow towards Holladay because of the presence of large deposits of clay. The presence of this clay has caused the Holladay springs water to come to the ground surface as high in the valley as it does, otherwise, it would have continued under the ground surface to a lower part of the valley until it intercepted the normal ground-water levels. The ground water found west and southwest of Holladay comes from the Big Cottonwood Creek channel area immediately west of the Wasatch Fault. It is known that water from this Big Cottonwood Creek channel area recharges as far north as 4500 South and Highland Drive. It is also known that the water lost to the ground in the vicinity of Parleys Creek, Mill Creek and Neff Creek, contribute to the ground-water supply at 3900 South and Highland Drive. These points are known. It is probable that waters from these two recharge sources commingle some place between the two points on Highland Drive. This probability increases towards the west and decreases towards the east in the direction of the Holladay springs. Ground water is obtained rather readily in the Big Cottonwood Creek area, along Highland Drive and in the Mill Creek area, but the possibilities of obtaining ground water decrease in the vicinity of Holladay. Holladay, being between the creeks, has perhaps never been worked over by stream action. The unconsolidated material found in this area, has, no doubt, been deposited from Lake Bonneville and is therefore fine and somewhat impervious. Yet, from the top of this unconsolidated material issues a large stream of water approximately 200 feet above the normal ground-water level in the surrounding area.

As a result of this investigation I have arrived at the following conclusions:

Summary of findings

1. The water that comes out of Neff Canyon, as measured just above the "Y", is but a small portion of that precipitated in the canyon during the year.

2. The water freely enters a rock formation that has great flow capacity, but very little storage capacity. The area called the sump is the last such area in the canyon that loses an appreciable amount of water. There may well be some of these losing areas in Norths Fork, but the water lost is very small compared to that in Neff Canyon.

3. The majority of the water issuing at Mt. Olympus Spring comes from Neff Canyon.

The clincher

4. The water lost into the rocks and sumps above the "Y", or shale formation, does not contribute to the normal ground-water supply of the valley, but does contribute to the flow of Holladay springs. Thus the Neff Canyon and Norths Fork area may well be the sole source of the Holladay springs.

5. The water lost to the creek channel below the "Y" does not contribute to the flow of Holladay springs, but does contribute to the normal ground-water supply of the valley.

It is, therefore, recommended that Mt. Olympus' Permanent Change Application No. a-2084 be approved in part. The point of diversion should be located at the "Y", in order that water may run over the sump area as it

has in the past, and according to previous agreement signed in 1900. This, of course, is based upon the belief that the water lost in the sump contributes to the flow of the Holladay springs. It is assumed, however, that all of the water of the Holladay springs during this period of time is appropriated.

It is also recommended that the Mulholland Application, No. 18119, which proposes to appropriate the water lost in the creek channel, between the "Y" and the Mulholland head gate, be approved.

It is also recommended that the J. Edward Taylor Application, No. 18056, which proposes to appropriate water in Norths Fork above the "Y", be rejected.

The following tabulation and remarks may be of interest.

	Total Quantity Measured, in Acre Feet		
Norths Fork - 2.5' rectangular weir	718.8		
Norths Fork - 6" cast iron pipe, during high flow	29.9		
Total Norths Fork		748.7	-12.2%
Neff Canyon - 2.5' rectangular weir	381.7	381.7	6.2%
Total from both forks (not including Peterson Basin)		1,130.4	18.4 %
Passing Mathews head gate	659.9		
Passing Mulholland head gate	635.9		
Dry Creek Spring	1,128.9	18.4%	
Casto Spring (including est. 10 ac. ft. going in pipe line above weir)	1,104.4	18.%	
Spring Creek (including pipe line water - see Chart 8)	2,760.9	45%	
Total from springs		4,994.2	81.4%
Total of springs and surface flow from both forks		6,124.6	

The Salt Lake City Water Department did obtain one set of readings of the depth of snow and water content in Neff Canyon at elevations of about 6000 feet and 6750 feet, on March 26, 1949.

At an elevation of about 6000 feet the snow depth was 53 inches and its water content was 19 inches. At an elevation of approximately 6750 feet the snow depth was 64 inches and the water content was 22 inches. Mt. Olympus has an elevation of ~~10,500 feet~~. There are only two or three mountains in the vicinity of Brighton that are higher. The whole rim of Neff Canyon is in the neighborhood of 10,000 feet. It is possible for the

Neff Canyon area to receive more precipitation than other areas along the Wasatch front in Salt Lake County.

On March 29, 1949, the average water content of the snow in Lambs Canyon was 19.4 inches at an elevation of 6600 feet.

No readings of water content are made in Big Cottonwood Canyon at an elevation comparable with those elevations at which readings were made in Neff Canyon. At Silver Lake, where the elevation is 8700 feet, the average snow depth was 97 inches and its water content was 32.7 inches. The total precipitation at this point for the calendar year of 1948 was 45.64 inches, and the normal precipitation at this elevation is 40.93 inches. The normal precipitation at higher elevations is greater in this vicinity.

In the absence of more information regarding the precipitation of Neff Canyon certainly nothing will be lost and perhaps much gained if an average precipitation is arrived at from the readings given above.

Using a figure of 36 inches per year, and a total drainage area of 3.4 sq. mi. above the "Y", the total precipitation would amount to 6,528 ac. ft. It is not impossible for the average reading to be as high as 42 inches of water per year. This would result in a total precipitation of 7,616 ac. ft.

Neff Canyon and Norths Fork are very steep and rugged areas. There is very little soil or unconsolidated material in the canyons. Most of the area the rock formation is at the surface. There is, therefore, very little material where water may be stored. As a result, the runoff is very rapid. The same proportions of the available water cannot be divided between evaporation, transpiration and runoff as exists in other mountain areas.

JAW/mv